

LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Thermodynamic Treatment of Chemical Equilibria in Systems Composed of Real Gases. II. A Relation for the Heat of Reaction Applied to the Ammonia Synthesis Reaction. The Energy and Entropy Constants of Ammonia. A Correction.

In a paper having the above title, published in the Physical Review **36**, 1008 (1930) the

No changes are necessary in part I, Phys. Rev. **36**, 743 (1930), or part III, Jour. Am.

TABLE IV. Values of several thermodynamic quantities for one mole of hydrogen, nitrogen and ammonia at 0°C and 1 atmosphere; and the increase Δ of these quantities when one mole of ammonia is formed from its elements all reactants and products being at 0° and 1 atmosphere. Units: 15°-calories, degrees Centigrade, moles.

	Hydrogen	Nitrogen	Ammonia	Δ
U	0	0	-10078.0	-10078
H	543.0	542.4	-9542.9	-10628.5
S	0	0	-23.0538	-23.054
F_{YT}	0	0	-3781.3	-3781
F_{pT}	543.0	542.4	-3246.2	-4332
pV	542.96	542.39	535.14	-550.50

numerical value given for the quantity $\Sigma(\nu_i s_{0i}')$ has been found incorrect. Eq. (13) should read: $\Sigma(\nu_i s_{0i}') = -22.9850$. The entropy constant (s_{0i}') for ammonia appearing in Table III should be -22.9809 . This requires several corrections in Table IV, which when revised is as follows.

Chem. Soc. **52**, 4239 (1930), of the series of three papers.

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February 10, 1931.

Reflection of High Velocity Electrons from Solid Surfaces

Bothe¹ has derived an expression for the angular distribution of electrons which are transmitted by matter and which have penetrated sufficient thickness to become completely diffused, and finds fair agreement with experimental work done with β -particles. It becomes of interest² to know the angular distribution of electrons emitted backwards from solid surfaces, since it is possible that the two distributions are similar. This question, together with the determination of absolute values of reflection, was studied during an investigation on scattering of high velocity electrons by thin foils.

If we call the half-angle of the solid cone about the normal to the surface, θ_1 , and the half-angle subtended by the opening through

which the electrons emerge, θ_2 , then experimentally all electrons, due to an originally homogeneous beam, emitted between these two cones are collected in a field-free space. The ratio of this number to the total number incident on the surface will be called ρ' . A small correction (less than 2 percent) may be made to ρ' for the electrons which come back between θ_2 and 0°. The corrected value, ρ , is then plotted as a function of θ . The following elements have been tested: Pb, Sn, Cu, Al, C, Be. The curve showing the variation of ρ with angle, for the heavier elements and voltages above 100,000, agrees with the curve $\rho_0 \sin^2 \theta$ to within 1 percent, where ρ_0 is the

¹ W. Bothe, Zeits. f. Physik **54**, 161 (1929).

value of ρ at $\theta=90^\circ$. The intensity at any angle is therefore given by the simple cosine law. Small deviations from this law are found for the lighter elements such as C and Be, especially at voltages below 70,000. More investigations are being conducted. Bothe's expression for the angular distribution of transmitted electrons which are completely diffracted, deviates from the distribution found experimentally for electrons emitted in a backward direction, by about 5 percent at $\theta=45^\circ$, both curves coinciding at 0° and 90° .

For beryllium ρ_0 , or the "rediffusion constant" of Webster,² is found to be 0.0291 for 70,000 volt electrons and decreases to 0.0248 at 130,000 volts, instead of being 0.043 which

he deduces. These values include all electrons emitted. In the case of beryllium, only 2 percent of the emitted electrons have energies below 2,000 volts.

A decrease in ρ is found for all the lighter elements with increase of voltage. In the range between 45,000 and 130,000 volts, this decrease amounts to 7 percent in the case of aluminum, becomes 0.6 percent for tin and less than 0.1 percent for lead.

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February 7, 1931.

² D. L. Webster, Phys. Rev. **37**, 119 (1931).

The Extrapolation of Atomic Structure Factor Curves

In a recent¹ note under the above title, D. K. Froman has derived an extrapolation formula for atomic structure factors on the basis of "electron distributions indicated by the wave equation." Although it is certainly true that quantum mechanics can be taken as the basis for deriving such formulas, it is of interest to note that Froman's result can be obtained without any appeal to a specific theory of the electron distribution causing the atomic structure factor. We have in mind simply the fact that repeated integrations-by-parts of Froman's Eq. (2) which defines the structure factor of the n^{th} order gives us at once the result that:

$$F_n = \sum_k a_{kn} \left(\frac{D}{n}\right)^{2k} = \sum_k a_{kn} \left(\frac{2 \sin \theta}{\lambda}\right)^{-2k}$$

¹ D. K. Froman, Phys. Rev. **36**, 1339 (1930).

where:

$$a_{kn} = \frac{(-1)^k}{(2\pi)^{2k}} \left[\left(\frac{U(r)}{r} \right)^{(2k-2)} \cos \frac{2\pi nr}{D} \right]_{r=0}^{r=D/2},$$

the notation being that used by Froman.

The first equation is clearly identical with Froman's Eq. (8), and his Eq. (12) can be derived similarly. It is thus seen that Froman's extrapolation formula is the general consequence of the definition of the structure factor, being in fact, the asymptotic expansion for F_n , and is independent of any wave-mechanical interpretation of the electron distribution.

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Nuclear Spin of Aluminum

The recent letter by J. H. Bartlett, Jr. on nuclear spin has been read with a great deal of interest, and in view of the importance of the subject the writers would like to point out an apparent discrepancy. After a careful survey of the work done on the hyperfine structure of the lines of various elements, the writers had reached the same general conclusions as Bartlett. It was disconcerting, however, to find that Janicki (Ann. **29**, 833, (1909)) and Wali-Mohammed (Astrophys. J. **39**, 185, (1914)) had both photographed the Al lines 3944A and 3961A using Lummer-Gehrcke plates and found them "very sharp and simple."

Recently, while studying different light sources for the purpose of finding the most

suitable source for use in analyzing the hyperfine structure nitrogen lines, occasion presented itself for photographing the following Al lines in a Schuler hollow cathode discharge cooled by liquid air.

A Fabry-Perot interferometer, with fixed etalons, was used in conjunction with a Zeiss triple prism spectrograph for analyzing the lines. Several exposures, made under different conditions and with different etalons, were made on each line. Mirrors having a reflection coefficient of 90 percent or greater were used, so that the resolving power of the interferometer was about 10^6 . Under these conditions all four Al lines were found to be sharp and lacking in structure.

Typical microphotometer curves of these